

LM230WF5
Liquid Crystal Display

Product Specification

SPECIFICATION
FOR
APPROVAL

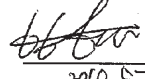
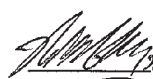
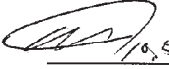
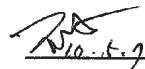
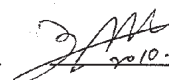
- () Preliminary Specification
(◆) Final Specification

Title		23" Full HD TFT LCD	
BUYER	LGE	SUPPLIER	LG Display Co., Ltd.
MODEL		*MODEL	LM230WF5
		SUFFIX	TLC2

*When you obtain standard approval,
please use the above model name without suffix

SIGNATURE	DATE
/	
/	
/	

Please return 1 copy for your confirmation
With your signature and comments.

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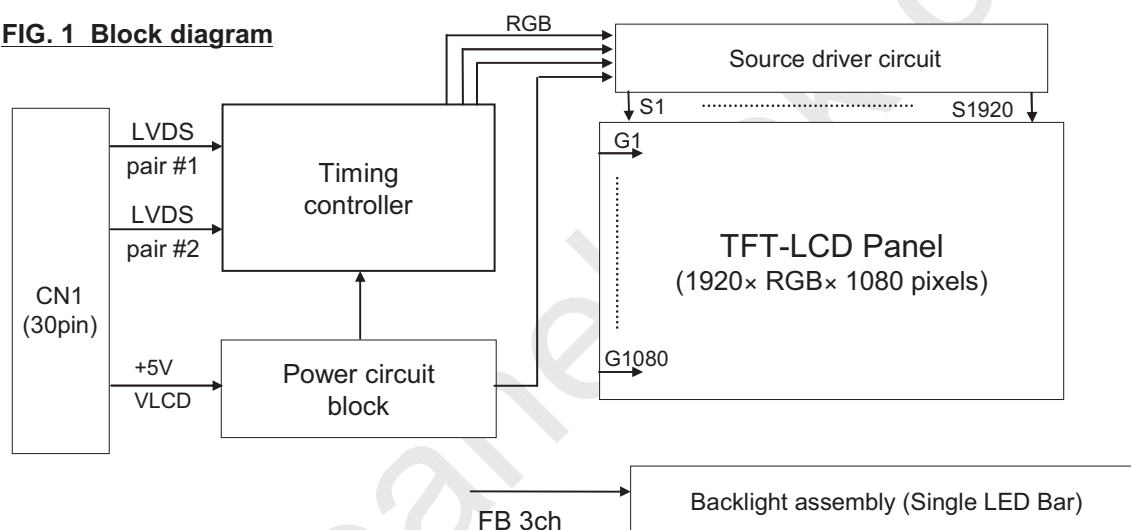
Product Engineering Dept.
LG Display Co., Ltd

LM230WF5
Liquid Crystal Display**Product Specification****Contents**

No	ITEM	Page
	COVER	1
	CONTENTS	2
	RECORD OF REVISIONS	3
1	GENERAL DESCRIPTION	4
2	ABSOLUTE MAXIMUM RATINGS	5
3	ELECTRICAL SPECIFICATIONS	6
	1) ELECTRICAL CHARACTERISTICS	6
	2) INTERFACE CONNECTIONS	8
	3) LVDS characteristics	11
	4) SIGNAL TIMING SPECIFICATIONS	14
	5) SIGNAL TIMING WAVEFORMS	15
	6) COLOR INPUT DATA REFERNECE	16
	7) POWER SEQUENCE	17
	8) POWER DIP CONDITION	18
4	OPTICAL SPECIFICATIONS	19
5	MECHANICAL CHARACTERISTICS	24
6	RELIABILITY	27
7	INTERNATIONAL STANDARDS	28
	1) SAFETY	28
	2) EMC	28
8	PACKING	29
	1) DESIGNATION OF LOT MARK	29
	2) PACKING FORM	29
9	PRECAUTIONS	30
	1) MOUNTING PRECAUTIONS	30
	2) OPERATING PRECAUTIONS	30
	3) ELECTROSTATIC DISCHARGE CONTROL	31
	4) PRECAUTIONS FOR STRONG LIGHT EXPOSURE	31
	5) STROAGE	31
	6) HANDLING PRECAUTIONS FOR PROTECTION FILM	31

Product Specification**1. General description**

LM230WF5-TLC2 is a Color Active Matrix Liquid Crystal Display Light Emitting Diode (White LED) backlight system without LED driver. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally white mode. It has a 23 inch diagonally measured active display area with FHD resolution (1080 vertical by 1920 horizontal pixel array) Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,7M colors with Advanced-FRC(Frame Rate Control). It has been designed to apply the interface method that enables low power, high speed, low EMI. FPD Link or compatible must be used as a LVDS(Low Voltage Differential Signaling) chip. It is intended to support applications where thin thickness, wide viewing angle, low power are critical factors and graphic displays are important. In combination with the vertical arrangement of the sub-pixels, the LM230WF5-TLC2 characteristics provide an excellent flat panel display for office automation products such as monitors.

FIG. 1 Block diagram**General features**

Active screen size	23 inches(58.42cm) diagonal(Aspect ratio 16:9)
Outline Dimension	533.2(H) x 312.0(V) x 11.5(D) mm(Typ.)
Pixel Pitch	0.265mm x 0.265mm
Pixel Format	1920 horizontal By 1080 vertical Pixels. RGB stripe arrangement
Interface	LVDS 2Port
Color depth	16.7M colors
Luminance, white	250 cd/m ² (Center 1Point, typ)
Viewing Angle (CR>10)	R/L 170(Typ.), U/D 160(Typ.)
Power Consumption	Total 18.95 W (Typ.), (4.5 W@V _{LCD} , 14.45 W@W/O_Driver)
Weight	1900 g (Typ.)
Display operating mode	Transmissive mode, normally White
Surface treatments	Hard coating (3H), Anti-glare treatment of the front polarizer

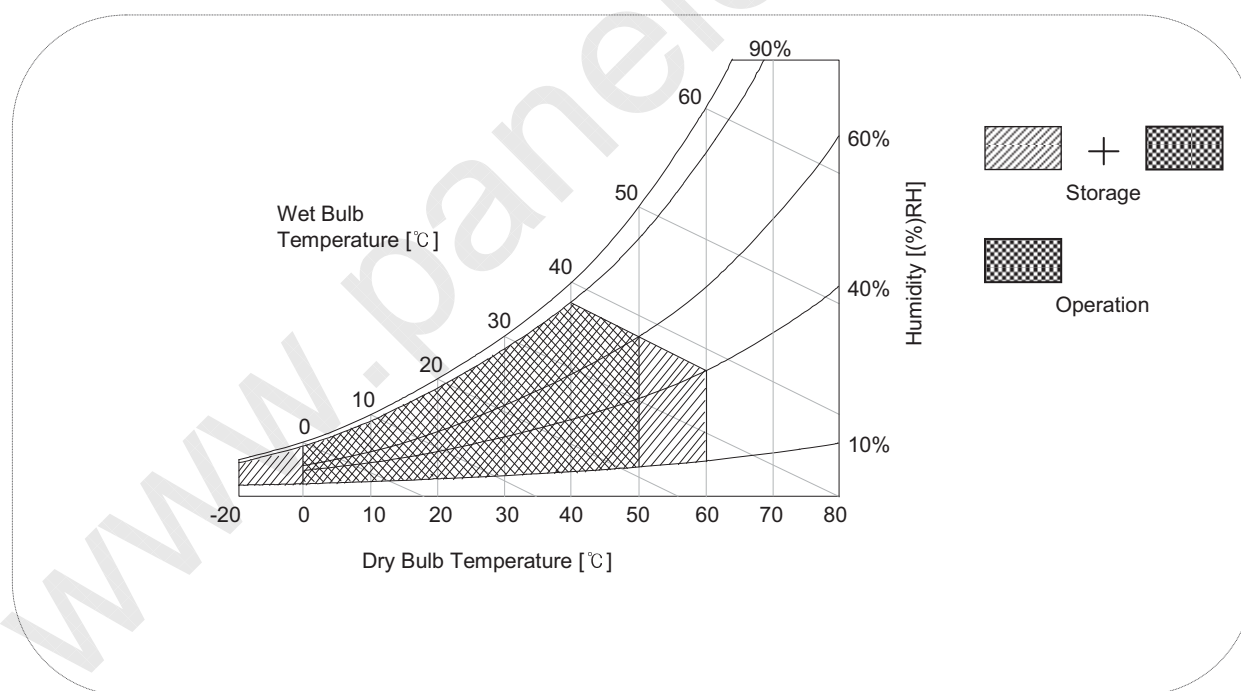
Product Specification
2. Absolute maximum ratings

The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. Absolute maximum ratings

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Supply Input Voltage	V_{LCD}	-0.3	+6.0	Vdc	At 25°C
Operating Temperature	T_{OP}	0	50	°C	1
Storage Temperature	T_{ST}	-20	60	°C	
Operating Ambient Humidity	H_{OP}	10	90	%RH	
Storage Humidity	H_{ST}	10	90	%RH	

Note : 1. Temperature and relative humidity range are shown in the figure below.
 Wet bulb temperature should be 39 °C Max, and no condensation of water.

FIG. 2 Temperature and relative humidity


Product Specification**3. Electrical specifications****3-1. Electrical characteristics**

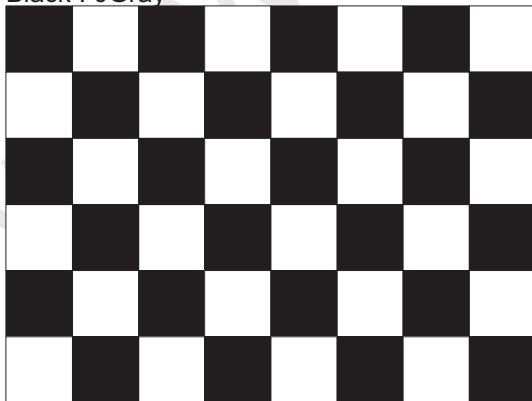
It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input power for the CCFL/Backlight, is typically generated by an inverter. The inverter is an external unit to the LCDs.

Table 2. Electrical characteristics

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V _{LCD}	4.5	5.0	5.5	Vdc	
Permissive Power Input Ripple	V _{LCD}	-	-	0.4	V	3
Power Supply Input Current	I _{LCD-MOSAIC}	-	900	1100	mA	1
	I _{LCD-BLACK}	-	1100	1250	mA	2
Power Consumption	P _{LCD}	-	4.5	5.5	Watt	1
Inrush current	I _{RUSH}	-	-	3.0	A	3

Note :

1. The specified current and power consumption are under the $V_{LCD}=5.0V$, $25 \pm 2^{\circ}C$, $f_v=60Hz$ condition whereas mosaic pattern(8 x 6) is displayed and f_v is the frame frequency.
2. The current is specified at the maximum current pattern.
3. Permissive power ripple should be measured under $VCC=5.0V$, $25^{\circ}C$, f_v (frame frequency)=75Hz condition and At that time, we recommend the bandwidth configuration of oscilloscope is to be under 20MHz.
4. The duration of rush current is about 2ms and rising time of power Input is 500us $\pm$ 20%.

FIG.3 pattern for Electrical characteristicspower consumption measurementWhite : 255Gray
Black : 0Gray

Mosaic Pattern(8 x 6)

power input ripple

Full Black Pattern

Product Specification**Table 3. LED bar Electrical characteristics**

Parameter	Symbol	Condition	Values			Unit	Notes
			Min.	Typ.	Max.		
LED :							1,7
LED String Current	Is_peak		-	110	130	mA	2,7
LED String Voltage	Vs		41	43.8	46.6	V	3,7
Power Consumption	PBar		13.53	14.45	15.38	Watt	4,6,7
LED Life Time	LED_LT		30,000	-	-	Hrs	5,7

LED driver design guide

: The design of the LED driver must have specifications for the LED in LCD Assembly.

The performance of the LED in LCM, for example life time or brightness, is extremely influenced by the characteristics of the LED driver.

So all the parameters of an LED driver should be carefully designed and output current should be Constant current control.

Please control feedback current of each string individually to compensate the current variation among the strings of LEDs.

When you design or order the LED driver, please make sure unwanted lighting caused by the mismatch of the LED and the LED driver (no lighting, flicker, etc) never occurs.

When you confirm it, the LCD module should be operated in the same condition as installed in your instrument.

1. Specified values are for a single LED bar.
2. The specified current is input LED chip 100% duty current.
3. The specified voltage is input LED string and Bar voltage at typical 110 mA 100% duty current.
4. The specified power consumption is input LED bar power consumption at typical 110 mA 100% duty current.
5. The life is determined as the time at which luminance of the LED is 50% compared to that of initial value at the typical LED current on condition of continuous operating at $25 \pm 2^{\circ}\text{C}$.
6. The LED bar power consumption shown above does not include loss of external driver.
The used LED bar current is the LED typical current.
Min Power Consumption is calculated with $P_{\text{Bar}} = V_{\text{s}}(\text{Min.}) \times I_{\text{s}}(\text{Typ.}) \times N_{\text{string}}$
Max Power Consumption is calculated with $P_{\text{Bar}} = V_{\text{bar}}(\text{Max.}) \times I_{\text{s}}(\text{Typ.}) \times N_{\text{string}}$
7. LED operating DC Forward Current and Junction Temperature must not exceed LED Max Ratings at $25 \pm 2^{\circ}\text{C}$.

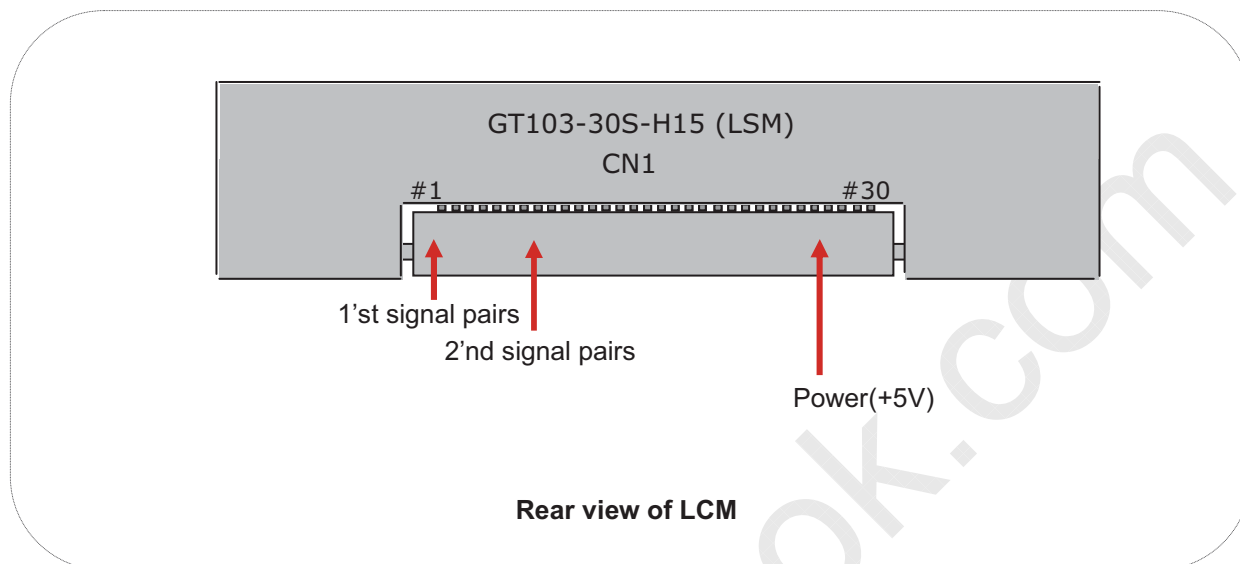
Product Specification**3-2. Interface connections**

LCD connector(CN1) : GT103-30S-H15 (LSM), IS100-L300-C23(UJU)

Mating connector : FI-X30H and FI-X30HL (JAE) or Equivalent

Table 4. Module connector(CN1) pin configuration

Pin No	Symbol	Description
1	RX00-	Minus signal of 1st channel 0 (LVDS)
2	RX00+	Plus signal of 1st channel 0 (LVDS)
3	RX01-	Minus signal of 1st channel 1 (LVDS)
4	RX01+	Plus signal of 1st channel 1 (LVDS)
5	RX02-	Minus signal of 1st channel 2 (LVDS)
6	RX02+	Plus signal of 1st channel 2 (LVDS)
7	GND	Ground
8	RXOC-	Minus signal of 1st clock channel (LVDS)
9	RXOC+	Plus signal of 1st clock channel (LVDS)
10	RX03-	Minus signal of 1st channel 3 (LVDS)
11	RX03+	Plus signal of 1st channel 3 (LVDS)
12	RXE0-	Minus signal of 2nd channel 0 (LVDS)
13	RXE0+	Plus signal of 2nd channel 0 (LVDS)
14	GND	Ground
15	RXE1-	Minus signal of 2nd channel 1 (LVDS)
16	RXE1+	Plus signal of 2nd channel 1 (LVDS)
17	GND	Ground
18	RXE2-	Minus signal of 2nd channel 2 (LVDS)
19	RXE2+	Plus signal of 2nd channel 2 (LVDS)
20	RXEC-	Minus signal of 2nd clock channel (LVDS)
21	RXEC+	Plus signal of 2nd clock channel (LVDS)
22	RXE3-	Minus signal of 2nd channel 3 (LVDS)
23	RXE3+	Plus signal of 2nd channel 3 (LVDS)
24	GND	Ground
25	NC	No Connection (For LCD internal use only.)
26	NC	No Connection (For LCD internal use only.)
27	NC	No Connection (For LCD internal use only.)
28	V _{LCD}	Power Supply (5.0V)
29	V _{LCD}	Power Supply (5.0V)
30	V _{LCD}	Power Supply (5.0V)

Product Specification**FIG. 4 Connector diagram****Note:**

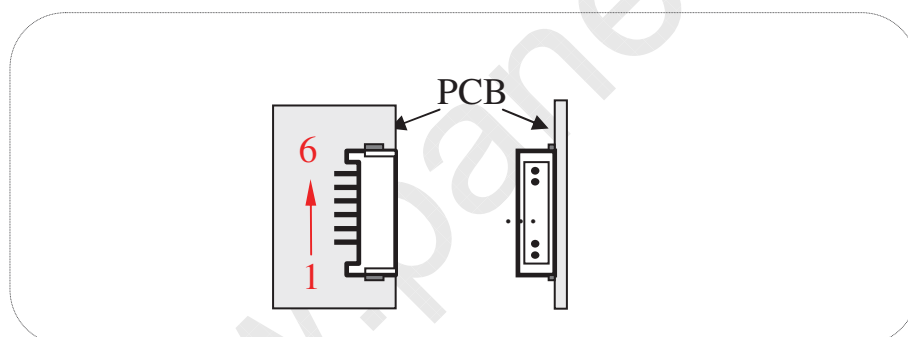
1. NC: No Connection.
2. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
3. All V_{LCD} (power input) pins should be connected together.
4. Input Level of LVDS signal is based on the IEA 664 Standard.

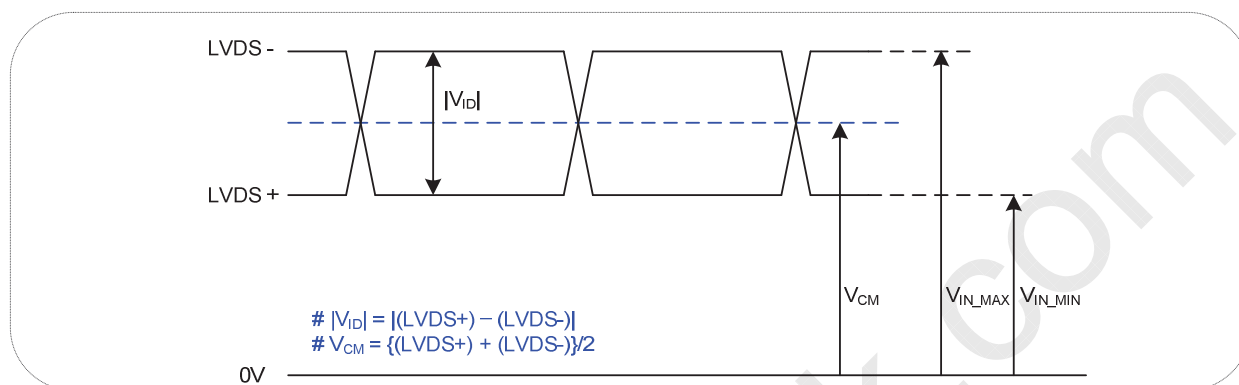
Product Specification

The LED interface connector is a model 05010HR-06D manufactured by YEONHO.
The mating connector is a FFC/FPC specified in LED interface connector specification.
The pin configuration for the connector is shown in the table below.

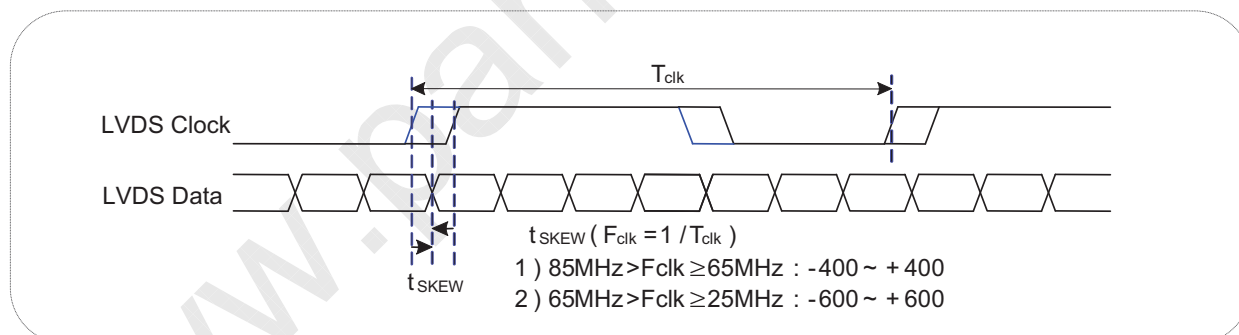
Table 5. LED connector pin configuration

Pin	Symbol	Description	Notes
1	FB1	Channel1 Current Feed Back	
2	FB2	Channel2 Current Feed Back	
3	Vled1	LED Power Supply	
4	Vled1	LED Power Supply	
5	NC	NC	
6	FB3	Channel3 Current Feed Back	

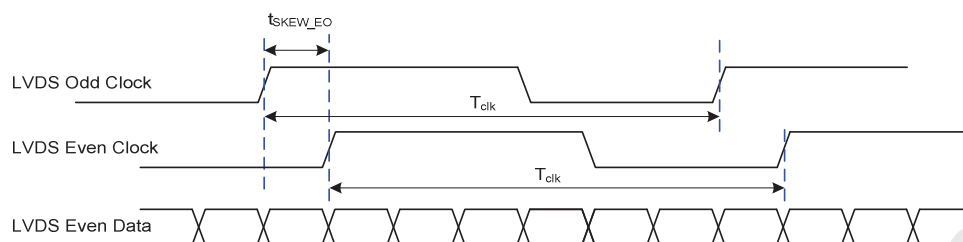
FIG. 5 Backlight connector view

Product Specification**3-3. LVDS characteristics****3-3-1. DC Specification**

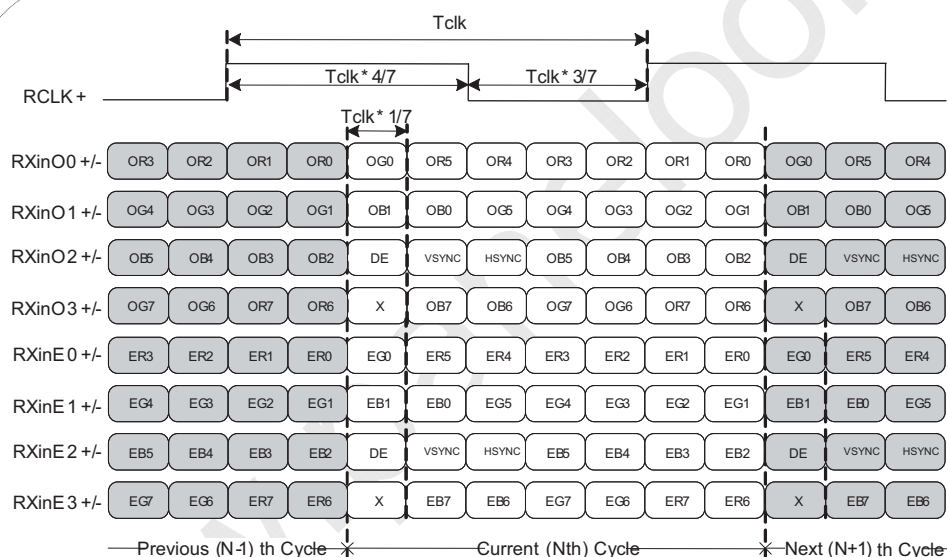
Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$ V_{ID} $	200	600	mV	-
LVDS Common mode Voltage	V_{CM}	0.6	1.8	V	-
LVDS Input Voltage Range	V_{IN}	0.3	2.1	V	-

3-3-2. AC Specification

Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- 400	+ 400	ps	$85MHz > F_{clk} \geq 65MHz$
	t_{SKEW}	- 600	+ 600	ps	$65MHz > F_{clk} \geq 25MHz$
LVDS Clock to Clock Skew Margin (Even to Odd)	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-

Product Specification


< Clock skew margin between channel >

3-3-3. LVDS Data format


MSB	R7
	R6
	R5
	R4
	R3
	R2
	R1
LSB	R0

* ODD = 1st Pixel
 EVEN = 2nd Pixel

< LVDS Data Format >

LM230WF5
Liquid Crystal Display

Product Specification

Table 6. Required signal assignment for Flat Link(NS:DS90CF383) transmitter

Pin #	Pin Name	Require Signal	Pin #	Pin Name	Require Signal
1	VCC	Power Supply for TTL Input	29	GND	Ground pin for TTL
2	D5	TTL Input (R7)	30	D26	TTL Input (DE)
3	D6	TTL Input (R5)	31	T _x CLKIN	TTL Level clock Input
4	D7	TTL Input (G0)	32	PWR DWN	Power Down Input
5	GND	Ground pin for TTL	33	PLL GND	Ground pin for PLL
6	D8	TTL Input (G1)	34	PLL VCC	Power Supply for PLL
7	D9	TTL Input (G2)	35	PLL GND	Ground pin for PLL
8	D10	TTL Input (G6)	36	LVDS GND	Ground pin for LVDS
9	VCC	Power Supply for TTL Input	37	T _x OUT3+	Positive LVDS differential data output 3
10	D11	TTL Input (G7)	38	T _x OUT3-	Negative LVDS differential data output 3
11	D12	TTL Input (G3)	39	T _x CLKOUT+	Positive LVDS differential clock output
12	D13	TTL Input (G4)	40	T _x CLKOUT-	Negative LVDS differential clock output
13	GND	Ground pin for TTL	41	T _x OUT2+	Positive LVDS differential data output 2
14	D14	TTL Input (G5)	42	T _x OUT2-	Negative LVDS differential data output 2
15	D15	TTL Input (B0)	43	LVDS GND	Ground pin for LVDS
16	D16	TTL Input (B6)	44	LVDS VCC	Power Supply for LVDS
17	VCC	Power Supply for TTL Input	45	T _x OUT1+	Positive LVDS differential data output 1
18	D17	TTL Input (B7)	46	T _x OUT1-	Negative LVDS differential data output 1
19	D18	TTL Input (B1)	47	T _x OUT0+	Positive LVDS differential data output 0
20	D19	TTL Input (B2)	48	T _x OUT0-	Negative LVDS differential data output 0
21	GND	Ground pin for TTL Input	49	LVDS GND	Ground pin for LVDS
22	D20	TTL Input (B3)	50	D27	TTL Input (R6)
23	D21	TTL Input (B4)	51	D0	TTL Input (R0)
24	D22	TTL Input (B5)	52	D1	TTL Input (R1)
25	D23	TTL Input (RSVD)	53	GND	Ground pin for TTL
26	VCC	Power Supply for TTL Input	54	D2	TTL Input (R2)
27	D24	TTL Input (HSYNC)	55	D3	TTL Input (R3)
28	D25	TTL Input (VSYNC)	56	D4	TTL Input (R4)

Notes : 1. Refer to LVDS Transmitter Data Sheet for detail descriptions.
2. 7 means MSB and 0 means LSB at R,G,B pixel data

Product Specification**3-4. Signal timing specifications**

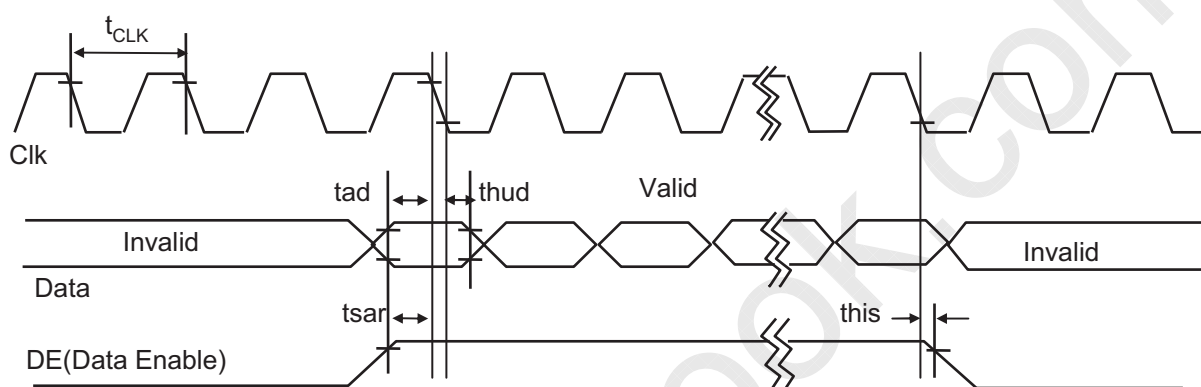
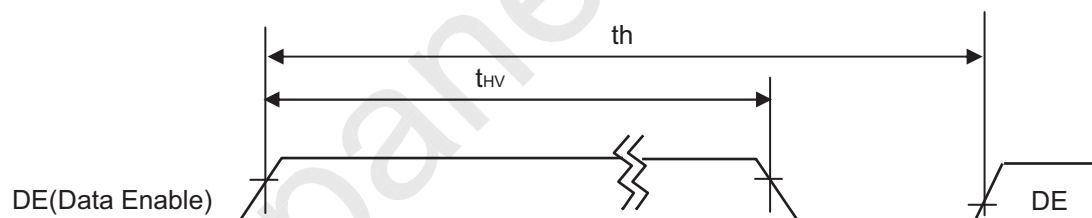
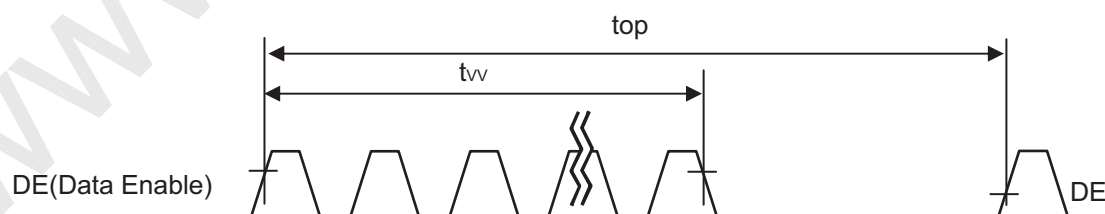
This is the signal timing required at the input of the User connector. All of the interface signal timing should be satisfied with the following specifications for it's proper operation.

Table 7. Timing table

Parameter		Symb ol	Min.	Typ.	Max.	Unit	Notes
D _{CLK}	Period	t _{CLK}	11.43	13.89	16.7	ns	Pixel frequency : Typ.144MHz
	Frequency	f _{CLK}	60	72	87.5	MHz	
Horizontal	H Period Total	t _{HP}	1000	1088	1120	t _{CLK}	
	Horizontal Valid	t _{HV}	960	960	960		
	Hsync Frequency	f _H	64	66	83	kHz	
Vertical	V Period Total	t _{VP}	1090	1100	1160	t _{HP}	
	Vertical Valid	t _{VV}	1080	1080	1080		
	Vsync Frequency	f _V	50	60	75	Hz	
DE (Data Enable)	DE Setup Time	t _{SI}	4	-	-	ns	For D _{CLK}
	DE Hold Time	t _{HI}	4	-	-		
Data	Data Setup Time	t _{SD}	4	-	-	ns	For D _{CLK}
	Data Hold Time	t _{HD}	4	-	-		

Note:

1. DE Only mode operation. The input of Hsync & Vsync signal does not have an effect on LCD normal operation.
2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
3. Horizontal period should be even.

Product Specification**3-5. Signal timing waveforms****1. DCLK, DE, DATA waveforms****2. Horizontal waveform****3. Vertical waveform**



LM230WF5
Liquid Crystal Display

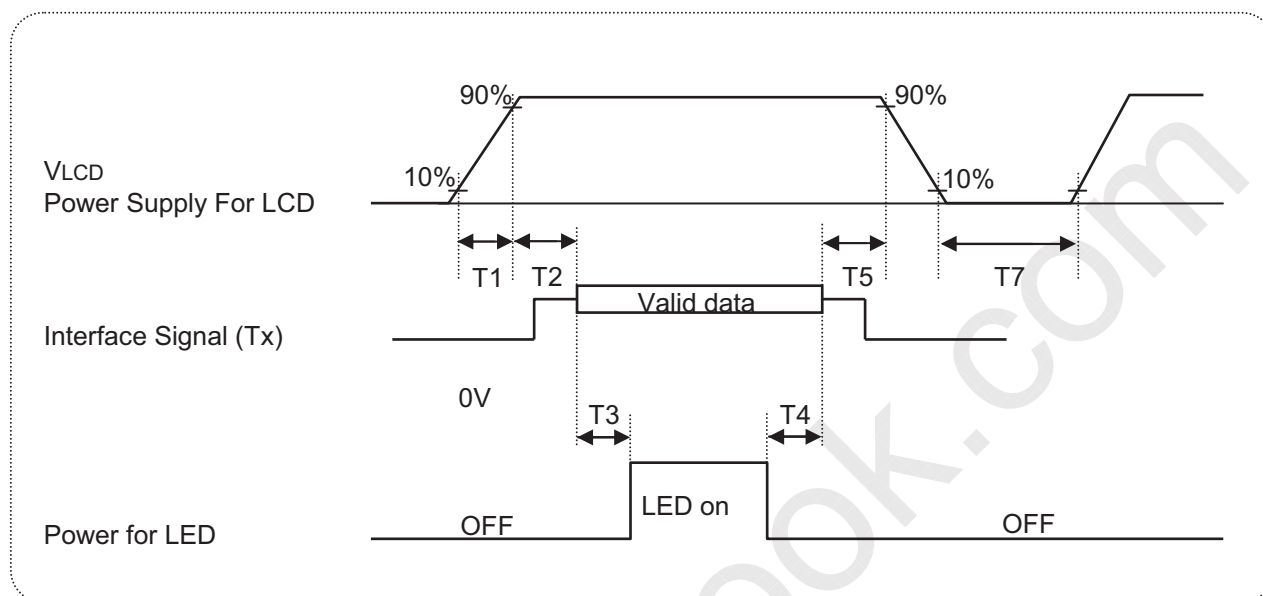
Product Specification

3-6. Color input data reference

The brightness of each primary color (red, green and blue) is based on the 8bit gray scale data input for the color ; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 8. Color data reference

Color		Input Color Data																							
		Red								Green								Blue							
		MSB				LSB				MSB				LSB				MSB				LSB			
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red	Red(000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(001)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(002)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Red(253)	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(255) Bright	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green	Green(000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green(001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Green(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
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	Green(253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
	Green(254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Green(255)Bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Blue	Blue(000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue(001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Blue(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Blue(253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
	Blue(254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue(255) Bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

Product Specification
3-7. Power sequence

Table 9. Power sequence

Parameter	Values			Units
	Min	Typ	Max	
T1	0.5	-	10	ms
T2	0.01	-	50	ms
T3	500	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T7	1	-	-	s

Notes :

1. Please V_{LCD} power on only after connecting interface cable to LCD.
2. Please avoid floating state of interface signal at invalid period.
3. When the interface signal is invalid, be sure to pull down the power supply for LCD V_{LCD} to 0V.
4. LED power must be turn on after power supply for LCD an interface signal are valid.

Product Specification**3-8. V_{LCD} Power dip condition**

1) Dip condition

$$3.5\text{V} \leq V_{\text{LCD}} < 4.5\text{V}, t_d \leq 20\text{ms}$$

2) $V_{\text{LCD}} < 3.5\text{V}$

V_{LCD} -dip conditions should also follow the Power On/Off conditions for supply voltage.